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Hospital- and community-acquired infections: a point prevalence and risk factors survey in a tertiary care center in Saudi Arabia

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Summary
Background: Point prevalence studies are useful in revealing the prevalence of hospital-acquired infections (HAIs) and community-acquired infections (CAIs). Such information allows prioritization of infection control resources and aids in overall hospital expenditure cut-backs.
Methods: A one-day point prevalence survey was conducted on May 19, 2003 at the King Fahad National Guard Hospital in Riyadh. Since the survey included HAIs and CAIs all patients were included. Data were collected on the underlying diagnosis, infection if present and whether it was hospital-acquired or community-acquired. We identified the presence of a line-associated blood stream infection (BSI), ventilator-associated pneumonia (VAP), catheter-associated urinary tract infection (UTI) or a surgical site infection (SSI) based on the United States National Nosocomial Infection Surveillance (NNIS) definitions.
Results: Five hundred and sixty-two inpatients were included in the survey. There were 38 patients with 45 (8.0%) HAIs and 76 (13.5%) patients with a CAI. Of the HAIs, 31.1% had a line-related BSI, while 28.9% and 24.4% had a VAP and catheter-related UTI, respectively. Most of the HAIs took place in the intensive care units (ICU) (21 (46.7%)), followed by the medical and surgical wards with six (13.3%) cases in each ward. For all HAIs there was a 12.7-fold increased risk with a hospital stay exceeding eight days (OR: 12.7, CI 3.2—50.6). Most of the 76 CAIs were admitted to the medical ward with community-acquired pneumonia (34.9%) as the most common diagnosis. Among the 89 pathogens isolated, *Pseudomonas aeruginosa* was the most common (21.3%) followed by *Enterococcus spp* (16.9%).

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Conclusions: The overall rate of HAIs in our hospital was 8%, with significant risk factors including a hospital stay exceeding eight days. A device-related infection was more likely in a patient with a venous or bladder catheter in place for more than eight days, or a patient mechanically ventilated for more than eight days. Catheter-related UTIs were identified as an important source of infection, requiring ongoing surveillance.

Introduction

Hospital-acquired infections (HAIs) are a significant clinical and economical burden worldwide.[1,2] An estimated 5–10% of all hospitalizations are complicated by a nosocomial infection with an estimated cost of $4.5–5.7 billion per year in the USA alone.[3–6] More recently, HAIs have been shown to be a significant economical burden in developing countries[2,7,8] including those of the Middle East. In 1970, Kuwait estimated that 5.1% of all hospitalizations developed an HAI with a daily cost of up to $267 000.[9]

The Gulf Co-operation Council (GCC) states health ministers mandated the development of infection control programs in all its states in 1980. The Kingdom initiated its infection control program in 15 Ministry of Health (MOH) hospitals, and by 1987 infection control programs were extended to all MOH hospitals. Subsequently, infection control programs were developed in other governmental hospital sectors including the military, university and private hospitals. The first Saudi MOH infection control manual was developed in 1984 with one of its main objectives being to monitor wards and clinics for infections and to implement other infection control standards. An infection control program was established with the opening of the King Fahad National Guard Hospital, Riyadh in 1983. As part of its mandate and ongoing activities it hosts biannual national/international conferences to address major infection control issues on travel medicine, bio-terrorism, prevention and management of nosocomial infections and training courses in infection control and hospital epidemiology for medical and non-medical professionals kingdomwide.[10,11]

As the primary aim, a one-day point prevalence survey was conducted to identify the extent of HAIs and the most likely risk factors leading to such infections in our facility. A second aim was to identify the prevalence of inpatients with community-acquired infections (CAIs) and the diseases necessitating their admissions. Since our surveillance program and activities are targeted by focusing on patients in specific risk groups,[12–15] this undertaking served as an adjunct to provide us with information on the infection status of our patients at a single point in time.

Methods

A one-day point prevalence survey was conducted at the King Fahad National Guard Hospital, King Abdulaziz Medical City, a 700-bed tertiary care center in Riyadh, Saudi Arabia on May 19, 2003. All hospital wards were included in the point prevalence survey. Affiliated to the infection control department are four infection control practitioners (ICPs), three infectious disease specialists and four public health nurses.

Experienced and certified ICPs and the infectious disease specialists developed the questionnaire form. Infection control practitioners were responsible for data collection and the training and supervision of additional staff that assisted in data collection. This included three public health nurses who are part of the Infection Control Department and two members from the Quality Management Department.

A main focus was HAIs involving line-related blood stream infections (BSIs), ventilator-associated pneumonias (VAPs), surgical site infections (SSIs), and catheter-related urinary tract infections (UTIs), and to separate these from CAIs. An infection was determined to be an HAI or a CAI based on United States National Nosocomial Infection Surveillance (NNIS)[16] definitions and was listed on each data collection sheet. The forms were reviewed and discussed with all the members participating in the data collection to emphasize the importance of data completeness. Standard information was collected on all patients in all wards. Each data collection sheet was composed of four sections. Section 1 detailed patient demographics and date of admission; section 2 the presence of a peripheral intravenous line or central line and any related infection, an endotracheal tube and any related infection, a foley catheter and any related infection, and a surgical site infection; section 3 detailed the presence of an HAI and the type of infection or a CAI and the type of infection; and section 4 detailed the results of pertinent microbiological samples tested, the pathogen isolated and the antibiotic sensitivity patterns. All microbiological samples that were taken in relation to the infection accounting for either an HAI or a CAI were reviewed and assessed on final reporting from the microbiology laboratory. The infectious diseases/hospital epidemiologist reviewed all 569 completed forms for further analysis.

Statistical methodology

All questionnaires on the point prevalence survey were checked and edited to ensure consistency of information. Statistical analysis was carried out using statistical software SAS version 8.2. Univariate and multivariate analyses of association of HAIs with all the risk factors were performed using the classical approach for analysis of the $2 \times k$ contingency tables and then repeated using logistic regression. Maximum likelihood estimates of odds ratio (OR) together with 95% confidence intervals (CIs) and the result of likelihood ratio tests for significance were computed with a p value of <0.05 used for statistical significance.

Results

General patient characteristics

On the day of the survey the hospital had an occupancy rate of 80% and a total of 562 patients were included in the study;

Table 1 Demographic data

	All infections				Non-infected		Total	
	HAI		CAI					
	No.	(%)	No.	%	No.	%	No.	%
Sex								
Male	31 [a]	68.9	44	57.9	229	51.1	304	53.4
Female	14	31.1	32	42.1	219	48.9	265	46.6
Total	45	100.0	76	100.0	448	100.0	569 [b]	100.0
Age group								
<1 Year	8	17.8	6	7.9	47	10.5	61	10.8
1–9	3	6.7	11	14.5	54	12.1	68	12.0
10–19	4	8.9	5	6.6	24	5.4	33	5.8
20–29	9	20.0	5	6.6	71	15.8	84	14.8
30–39	4	8.9	3	3.9	65	14.5	72	12.7
40–49	3	6.7	13	17.1	32	7.1	47	8.3
50+	14	31.1	33	43.4	155	34.6	202	35.6
Total	45	100.0	76	100.0	448	100.0	569 [b]	100.0

Table shows data relating to episodes of infection. One patient from each age group (except the age group 20–29) had two infections each. In the age group 50+ two patients had a double infection.

[a] Seven male patients had two infections each (seven patients counted twice, 24 male patients had 31 infections).

[b] 562 patients had a total of 569 infections (448 patients non-infected, 114 patients infected).

there were 297 males and 265 females. The average age was 36.8 years among the males while the females had an average age of 36.2 years.

Of the 562 patients surveyed 114 [38 HAI patients + 76 CAI patients] had an infectious process (Table 1). Seven patients had two infections leading to a total of 121 [45 HAIs + 76 CAIs] infections. All of the seven patients who had two infections were male and all were HAIs.

Hospital-acquired infections

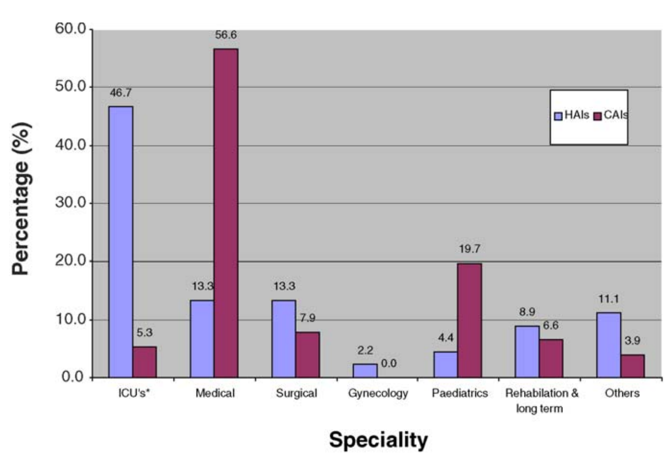
The prevalence for HAIs was 8%. The majority of patients with an HAI were above the age of 50 (31.1%), followed by the age group 20–29 (20%) (Table 1). Among the pediatric group aged 0–19 years, more children under the age of one year ($n = 7$, 58.3%) had an infection compared to those above 50 years in the adult age group 20 years and above ($n = 12$, 46.2%) (statistics not detailed in Table 1).

The most common HAI was line-related BSIs ($n = 14$, 31.1%), followed by VAPs ($n = 13$, 28.9%) and catheter related UTIs ($n = 11$, 24.4%). Among the HAIs, 21 (46.7%) occured in the ICUs, while in each of the medical and surgical wards, six (13.3%) HAIs occured (Table 2, Figure 1). The majority of HAIs in the ICU were VAPs (47.6%), followed by line-related BSIs and catheter-related UTIs (19%) each.

There was no increased risk of developing an HAI when comparing males and females or among the different age groups. However, the risk of developing an HAI was 9.1 times higher among patients who were admitted to the ICU in comparison to those admitted to non-ICU wards (Table 3). The likelihood of developing an HAI was 16.4 times higher for those with a hospital stay exceeding eight days, and the likelihood of developing a catheter-related UTI was 10 times higher in patients catheterized for more than eight days ($p < 0.005$). The risk of developing a line-related BSI or a VAP was much higher in those who had a line or were ventilated for more than eight days ($p < 0.005$) (Table 3). On the surgical wards, six HAIs were documented, none were surgical site infections (SSIs) and the only wound infection documented was a bed sore (Table 2).

Community-acquired infections

The prevalence of patients admitted with a CAI in the survey was 13.5%. The majority of patients admitted to the hospital with a CAI were above 50 years of age, followed by the age group 40–49. At the time of the survey none of the patients admitted with a CAI developed an HAI (Table 1). The most common admission diagnosis was community-acquired pneumonia, accounting for 30.3% of all CAIs. This was followed by UTIs not related to the presence of a catheter, and BSIs not



* Includes adult and pediatric, cardiac and burns ICUs, PICU and NICU.

Figure 1 Distribution of HAIs and CAIs according to ward specialty — May 19, 2003.

Table 2 Distribution of HAIs and CAIs among different hospital wards

Type of infection	Wards															
	Intensive care units[a]		Medical wards		Surgical wards		Gynecology wards		Pediatric wards		Rehabilitation and long-term		Others		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Hospital-acquired infections																
BSI	4	19.0	0	0.0	1	16.7	1	100	2	100.0	3	75.0	3	60.0	14	31.1
VAP	10	47.6	0	0.0	3	50.0	0	0.0	0	0.0	0	0.0	0	0.0	13	28.9
UTI	4	19.0	3	50.0	1	16.7	0	0.0	0	0.0	1	25.0	2	40.0	11	24.4
Pneumonia	1	4.8	1	16.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	4.4
Wound infection	2[b]	9.5	0	0.0	1[b]	16.7	0	0.0	0	0.0	0	0.0	0	0.0	3	6.7
Others	0	0.0	2	33.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	4.4
Total	21	100	6	100	6	100	1	100	2	100	4	100	5	100	45	100
Community-acquired infection																
BSI	2	50.0	6	14.0	0	0.0	0	0.0	4	26.7	0	0.0	0	0.0	12	15.8
VAP	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	40.0	0	0.0	2	2.6
UTI	1	25.0	10	23.3	0	0.0	0	0.0	2	13.3	0	0.0	2	66.7	15	19.7
Pneumonia	1	25.0	15	34.9	0	0.0	0	0.0	6	40.0	1	20.0	0	0.0	23	30.3
Others	0	0.0	12	27.9	6	100	0	0.0	3	20.0	2	40.0	1	33.3	24	31.6
Total	4	100	43	100	6	100	0	0	15	100	5	100	3	100	76	100

BSI: bloodstream infection; VAP: ventilator-associated pneumonia; UTI: urinary tract infection.
[a] ICUs include: adult and pediatric cardiac and burn ICUs, PICU and NICU.
[b] No surgical site infection.

Table 3 Prevalence of HAIs according to patient characteristics (including risk factors) and specialties

	HAIs	Non-infected[a]	Prevalence of HAIs (%)	Odds ratio	p value[b] (95% CI)
Sex					
Male	31	229	10.5	1	$p = 0.02$
Female	14	219	5.3	0.47	(0.24–0.90)
Age group					
<1	8	47	13.3	1	$p = 0.38$
1–49	23	246	7.7	0.55	(0.23–1.3)
≥50	14	155	7.0	0.53	(0.21–1.34)
Specialties					
Medicine	6	98	4.1	1	$p < 0.0001$
Surgery	6	63	8.1	1.56	(0.48–5.0)
Obstetrics-gynecology	1	20	4.8	0.82	(0.09–7.2)
Pediatrics	2	55	2.8	0.59	(0.12–3.04)
Intensive care	21	45	31.3	7.6	(2.9–20.2)
Rehabilitation and long-term	4	68	5.5	0.96	(0.22–4.04)
Others	5	99	5.0	0.84	(0.21–3.25)
Length of hospital stay					
<8 days	3	251	1.0	1	$p < 0.0001$
8–13 days	9	46	14.8	16.4 (4.3–62.8)	$p < 0.0001$
>13 days	33	149	16.8	18.5 (5.6–61.5)	$p < 0.0001$
Patients with a urinary catheter and UTI					
<8 days	1	251	0.3	1	$p = 0.00$
8–13 days	2	46	3.3	10.9 (0.97–122.8)	0.053
>13 days	8	149	4.1	13.5 (1.67–108.8)	0.015
Patients with an ETT/ventilated and VAP					
<8 days	2	251	0.7	1	$p = 0.00$
8–13 days	4	46	6.6	10.9 (1.9–61.3)	0.007
>13 days	7	149	3.6	5.9 (1.2–28.7)	0.028
Patients with a PIV/CVL and a blood stream infection[c]					
<8 days	0.5	251.5	0.2	1	$p < 0.0001$
8–13 days	2.5	46.5	4.1	27.0 (1.3–572.4)	0.034
>13 days	12.5	149.5	6.3	42.0 (2.5–715.5)	0.0097

UTI: urinary tract infection; ETT: endotracheal tube; VAP: ventilator-associated pneumonia; PIV: peripheral intravenous line; CVL: central venous line.
[a] Excluding CAIs.
[b] $p < 0.05$ is significant.
[c] 0.5 added to each cell due to zero value in one cell, to determine p value and 95% confidence interval.

related to the presence of a line, 19.7% and 15.8%, respectively (Table 2). Most of the CAIs were on the medical wards ($n = 43$, 56.6%), followed by the pediatric wards ($n = 15$, 19.7%) (Table 2).

Microbiology data

All 121 episodes of infections had at least one clinical sample sent for microbiological testing as deemed appropriate by the managing team. A pathogen was isolated from 89 samples of 89 episodes of infection with no duplicates included. The most frequently isolated pathogens in descending order were, *Pseudomonas aeruginosa* (21.3%), *Enterococcus spp* (16.9%), *Klebsiella spp* (10.1%), *Staphylococcus spp*, including methicillin-sensitive *Staphylococcus aureus* (MSSA) and methicillin-resistant *Staphylococcus aureus* (MRSA) (13.5%) (Table 4).

Discussion

Point prevalence survey studies are conducted over one day and the results are expected to differ in the same hospital depending mainly on the time of year, patient volume and service load. For example, our survey was conducted in the middle of May, when the city of Riyadh is just exiting the winter season and many admissions are related to lower respiratory tract infections secondary to viral pathogens, such as respiratory syncytial virus (RSV) and influenza. This would explain our higher numbers of community-acquired respiratory infections compared to HAIs, a ratio of 1.7:1.

In a similar point prevalence survey conducted by Azzam and Dramaix in Lebanon, the HAI prevalence rate was 6.8%, slightly lower than our rate of 8%.[17] However, similar to our results, the ICUs had the highest rates of HAIs, 18.4%, followed by the medical wards, 5.8%. These results concur with

Table 4 Distribution of 89 pathogens from the point prevalence survey — May 19, 2003

Pathogen isolated	Positive cultures						
	HAIs		CAIs		*p* Value	Total	
	No.	(%)	No.	(%)		No.	(%)
Gram-negative pathogens							
Pseudomonas aeruginosa	12	63.2	7	36.8	0.16	19	21.3
Klebsiella spp	8	88.9	1	11.1	0.42	9	10.1
Pseudomonas spp	6	85.7	1	14.3	0.39	7	7.9
Enterobacter spp	2	33.3	4	66.7	0.20	6	6.7
Haemophilus spp	3	75.0	1	25.0	0.29	4	4.5
Other Gram-negative bacilli	1	16.7	5	83.3	0.37	6	6.7
Gram-positive pathogens							
MSSA	6	85.7	1	14.3	0.39	7	7.9
MRSA	4	80.0	1	20.0	0.29	5	5.6
Streptococcus pneumoniae	0	0.0	2	100.0	0.50	2	2.2
Other *Streptococcus spp*	2	100.0	0	0.0	0.50	2	2.2
CoNS[a]	3	42.9	4	57.1	0.09	7	7.9
Enterococcus spp	11	73.3	4	26.7	0.28	15	16.9
Total	58	64.8	31	35.2	0.2	89	100.0

MSSA: methicillin-susceptible *Staphylococcus aureus*; MRSA: methicillin-resistant *Staphylococcus aureus*.
[a] Coagulase negative staphylococcus.

many other studies from the developed countries, where the majority of HAIs occur in the ICUs.[16,18,19] This is to be expected since ICU patients are more likely to be critically ill and to endure multiple invasive procedures and indwelling lines. In a prospective survey conducted over a six-month period from a tertiary care hospital in Abu Dhabi, three areas were included, the ICU, male orthopedic ward and general surgery ward, and the prevalence of HAIs was highest among the ICU patients, 29.1%, followed by patients of the male orthopedic ward and general surgery ward, 6.5% and 5.7%, respectively.[20]

The most common HAI in our survey was line-related BSIs. This was in contrast to the results of Azzam and Dramaix[17] and El-Hagrassy,[20] where VAPs were the most common among the HAIs, while a report from Abha, Saudi Arabia, documented UTIs as the most common HAI.[21] The differences could be related to several factors, most importantly the definition used for HAIs, which may vary among the different studies, and the variation among patient populations. In our study, VAPs ranked second among the ICU HAIs. Our department has, for many years, been making major efforts to reduce the magnitude of VAPs in our ICUs. A prospective surveillance system has been in place since its implementation in 1996. Memish et al. reported a high VAP prevalence rate among the adult ICU patients between 1996 and 1997, 16.8/1000 ventilator days.[22] A second prospective study conducted over a two-year period among pediatric ICU (PICU) patients revealed a lower VAP rate of 8.87/1000 ventilator days[23], but almost double the NNIS PICU VAP rate of 4.9/1000 ventilator days.[16] Since then our hospital has implemented some preventative measures to reduce the VAP rates among our ICU patients. Heat and moisture exchanges were introduced on a trial basis, then became a standard of care in all ventilated patients with no contraindication.[24]

The design of our study, unfortunately, did not outline the different risk factors leading to HAIs such as co-morbidity factors and previous hospitalizations and surgical procedures. We were, however, able to show a possible association between a prolonged hospital stay and the occurrence of an HAI. Similarly, a significant increase in hospital-acquired BSIs, VAPs and UTIs with prolonged instrumentation is suggested by the data. This has clearly been proven by many other studies.[25–27] For line-related BSIs the Centers for Disease Control (CDC) has published guidelines to assist ICU patient caregivers in reducing the rates of line-related infections.[13] Similarly, guidelines for improving the standard of care given to patients who are ventilated or have a bladder catheter, in order to reduce the rates of VAPs and UTIs are available.[28,29] The CDC has clearly recommended the presence of an authoritative and leading infection control department whose members would assist in implementing and monitoring these guidelines.[3,30,31]

As with other reports, Gram-negative pathogens were responsible for most HAIs. Our samples, though, were too small to detect a statistical significance between pathogens causing HAIs and CAIs. From the 89 isolates, 12 were *Staphylococcus aureus*, five of which were MRSA. Of the latter, four were HAIs and one was a CAI indicating that 40% of HAIs secondary to *S. aureus* were MRSA infections. This was similar to a study published from Jeddah in 2001 where the prevalence of MRSA in two tertiary care hospitals was 33%.[32] Most of these isolates were from the ICU followed by the general medical wards. The emergence of MRSA as a major nosocomial pathogen has been recognized worldwide, and in major cities in the USA, MRSA in hospitals has risen from less than 3% to over 30% within the past three decades.[33,34] More alarming though, is the documented rise in the number of CAIs with MRSA and the major economic impact it has on the medical care system. Bukharie et al., from the Eastern province of Saudi Arabia, have shown a 15-fold increase in the number of MRSA-related CAIs over a three-year period.[35] In our institution there is an ongoing prospective survey to monitor MRSA infections and to ensure compliance with infection control practices of standard precautions and contact isolation when indicated, to limit the spread of such infections among patients. Our MRSA rate has remained between 10 and 15% over the last five years.[36]

Several points may be concluded from our study. A crude baseline HAI rate has been established. Our high rate of line-related BSIs mandate further investigation and more detailed surveys to outline the risk factors and possible methods of reducing their occurrence. Secondly, continuous surveillance on VAP should take place. Initiating a survey to monitor the occurrences of catheter-related UTIs would be critical to establish rates and plan interventional strategies. Finally, a more comprehensive survey to look into the magnitude of the misuse of antimicrobials in our institution should take place since we are keen on reducing the emergence of resistant pathogens, a problem that seems to be a major cause for concern in developing countries where considerable misuse of antibiotics is prevalent.

Conflict of interest: No conflict of interest to declare.

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